Entry for the 9th FQXi Essay Contest

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Theme:

Wandering Towards a Goal
How can mindless mathematical laws give rise to aims and intention?

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Where the Question Leads

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Preliminary note

Aims and intentions are not necessarily deliberate and do not necessarily spring from free will: a fruit fly, intent on finding its next meal, is hardly endowed with free will. The question of free will has been dealt with at length in literature [1], but consensus on whether it exists has so far remained elusive. Should the universe be without free will, human aims and intentions would *appear* to be deliberate and mindful, but would be every bit as mindless and impersonal as whatever mathematical laws would ultimately be choreographing the show.

The question as phrased could therefore mean two very different things, depending on whether the possibility of free will is entertained or not. Because nothing in the known laws of physics prevents the possibility of free will, this paper examines the question from a standpoint where free will is allowed.

Introduction

When attempting to answer any question, we must remember that not all questions are legitimate. Some, while seemingly clear-cut, are in fact so vague as to be properly

unanswerable (e.g. the hoary "Do you believe in God?", utterly meaningless unless both the words 'believe' and 'God' are precisely defined, with the latter capable of taking on a range of meanings depending on the asker—presumably from some bearded man harping on a cloud, all the way to something else entirely, including, perhaps, the live Schrödinger wave function of the universe or multiverse.) Some questions are plain wrong, and cannot properly be posed (the poster boy of which being "What came first, the chicken or the egg?", a thoroughly absurd question since the chicken and the egg co-evolved.)

Other questions may exhibit subtle cognitive bias that will, if undiscovered, skew the answering process and ultimately invalidate any answers. Such bias is typically embedded either in adjectives, because they qualify and color meanings, and/or in relationships stated *a priori* but not further examined nor justified, such as in time sequences and/or any turns of phrase that may subtly imply that some correlations imply causation.

As such, the question ' How can mindless mathematical laws give rise to aims and intention?' contains two markers of possible illegitimacy. The word 'mindless' is stated but not proven, and the phrase 'give rise' posits a stated but as yet unproven time sequence. There would be, for example, no *a priori* grounds to dismiss the remote possibility that, like humans and apes, both mathematical laws and mindful aims and intentions spring from an ultimately common source, rather than one from the other.

1- Background

The question would make little sense if it did not implicitly assume that the universe is ultimately purely mathematical. Although some still hold this assumption as controversial, the evidence that the universe is indeed purely mathematical is overwhelming.

Indirect Evidence

A very strong hint that our universe is purely mathematical, hardly recognized at the time, appeared in 1905 with the publication of Einstein's $e=mc^2$ formula, which demonstrated that astonishing very-real life effects happen just so that a purely mathematical equation not be violated. Further clues kept popping up right and left across the physical sciences, leading in 1960 to Eugene Wigner's celebrated paper on 'The Unreasonable Effectiveness of Mathematics in the Natural Sciences'.

In 1991, Michael Monatstyrsky published his monograph 'Modern Mathematics in the Light of the Field Medals' [2], in which, obviously puzzled, he commented on how *extremely* arcane and abstract mathematics (such as non-commutative algebraic geometry) kept routinely yielding up totally unforeseen real-world applications in diverse fields (such as solid state physics.)

If anything, the direct evidence is even more compelling.

Direct Evidence

Further to the discovery of the Higgs boson, the last ramparts of old-style Aristotelian math-free materialism came crumbling down (science journalist Stephen Battersby, foreseeing its discovery, had earlier jumped the gun and stated in a famous piece, 'It's Confirmed: Matter is Merely Vacuum Fluctuations' [3].) Separately, mathematicians from a number of narrow mathematical disciplines kept reinforcing this view. Shing-Tung Yau [4], for one, confirmed some of Einstein's insights and showed how pure geometry can give rise to gravity, and ultimately to mass itself.

Reinforcing this view from a different angle, if we take a physical chemistry view of all there is—of materiality itself—we soon find that all of the properties of any collection of material elements, the electrons, protons, neutrons and other building blocks of materiality, can be described by purely mathematical objects: their wave functions.

What is Math?

As Keith Devlin put it [5], math is, at its core, the expression of relationships - between objects, whatever they may be, such as things and mindstuff items (which of course need to be further defined.) The envelopes of these relationships give rise to patterns, which in turn become the subjects of the different branches of mathematics. From this definition, we already catch a glimpse of how mathematics could generate intentions in a purely mathematical universe, where intentions would result from the relationships of bits of mindstuff towards certain elements within their environment. Such interactions with the environment would inescapably be, in a mathematical universe, well—mathematical.

With math appearing to be the be-all and end-all, if we are to apprehend reality properly we need to be reasonably good at it. The unfortunate reality is that we are, as a species, not very good at math. For instance, we are unable to work out the wave functions of all but the very simplest material systems, such as an unbound electron or perhaps a hydrogen atom. Expressing the wave function of, say, even a few atoms kept in an insulating jar, away from any complicating interactions with the wider universe, is already beyond our abilities. Worse still, we sometimes seem to squarely misinterpret math—which routinely leads eminent scientists, such as Dieter Zeh and others, to cast withering doubt on our whole mathematical edifice [6],[7].

Here's an example.

Should our known universe be in fact, as is likely, a tiny subcomponent of a much wider, infinite multiverse, there is a line of thought, put forward by Colin Bruce [8] and many others, that this would inevitably result in the existence an infinite multitude of exact and near exact copies of you, me and everyone else, sprinkled across the multiverse. By *exact* copy is not simply meant an identical person, but an

identical person leading the exact same life within the exact same environment - along with further infinite retinues of near-exact copies leading near exact same lives (Various calculations have been made of the probable distance to anyone's nearest first exact duplicate in an infinite multiverse, which all yield a minimum distance way larger than the confines of our universe.) The reasoning behind the 'infinite number of copies' goes something like this: since you exist, the mathematical odds of your existing is not nil, no matter how vanishingly small it may be. In our finite universe, these mathematically infinitesimal odds have yielded, in the particular case of *you*, a probability of one, since you do exist (and zero for the immeasurably bigger number of people who could possibly exist but do not.) In an infinite metaverse though, these infinitesimal odds become multiplied by infinity, so that the resulting number of you's becomes (a very small but non-nil finite value) multiplied by (infinity): equals = infinity. Case closed? No, because this argument is actually flawed. There exists an infinity of infinities, expressed by an unending series of aleph number metrics. The infinity metric of an infinite universe is of a pretty low-ranking aleph metric (technically, aleph-1), whereas the chain of extremely unlikely events that came together to give birth to *you* appears to be, in an infinite universe, of a higher aleph metric. Bearing in mind that 1 divided by *any* infinity "*tends* " towards zero, rather than "*is equal*" to zero, it is entirely possible that you were born out of a chain of events from within a multi-layered infinite pool of possibilities, of a *higher* aleph metric than the low-ranking metric of a merely *geometrically* infinite universe. Since a higher aleph metric infinity divided by any lower ranking infinity is equal to infinity, of the higher metric, the odds are extremely in favor of you and your life being unique across the multiverse (A wholly different proof involving time is discussed in [9].) Those who bemoan the current state of physics and believe that it has become unmoored from reality may be barking up the wrong tree: any issues in contemporary physics could be solved by *more*, not less mathematics.

2- Parsing the Question

As noted above, the two possible markers of implicit cognitive bias are, respectively, the adjective 'mindless' and the expression 'give rise'.

Giving Rise?

This latter marker indicates a timelike sequence between the pre-existing presence of mathematical laws, and sentient, deliberate 'intentions'. If a timelike sequence of events is meaningful, then time must be shown to be an irreducible, fundamental property of any mathematical universe.

A simple mind game shows that this, however, cannot be the case.

Simple relativistic mathematics—the Lorentz transformation—shows that time, speed, and distance cannot be considered independently of one another but are inextricably entangled. The way this interdependence works out in the real world may

be counterintuitive: stay put and look towards some star light years away. You happen to be, as you contemplate deep space towards that star from your fixed position, simultaneous with some event A on it. But now walk towards it: you have now become simultaneous with some other event B on that star, that happened (depending on your walking speed and the distance to the particular star) hours or even days *earlier* than the event A you were simultaneous with mere seconds ago when you were standing still.
Now turn on your heels and walk *away* from the star: you have now become simultaneous with yet another event C, which took place hours or days *later* than A, and twice as long later than B.
So far so good, it's simple math. But what happens if you start spinning, dervish-like, around your body axis? Then the right half of your brains becomes instantly and continuously simultaneous with events on that distant star that are separate by hours or days from the events your brain's left side is simultaneous with, although both your brain halves are closely, if not perfectly, simultaneous with each other. The whole concept of time has irremediably broken down. My 2015 monograph [9] analyzed the issue and concluded that the only possible way out of the conundrum is that time cannot be a fundamental variable of a mathematical universe, but a side effect of something more fundamental. That more essential something turned out to have to be, in some form or other, *mindstuff*. (Note that this analysis only shows that mindstuff has to be a more fundamental property of the universe than time, not that there may not exist something else, deeper still than mindstuff.)

If time sequences are illusory exists between intentions and mathematics, we are left with only a few possibilities.

A first possibility is that intentions (mind) and mathematics are unrelated, i.e. ultimately emerge from different, unrelated sources. Either one, or both, or for that matter none of the two could turn out to be fundamental properties of the universe.

Another one is that they *are* related, and ultimately are the reflections or the perceivable aspects of a same underlying reality, which may then be either math, or mind, or some other Third Party to be determined. (For instance, there would be so many instances of the application of mathematical laws in a vast universe that it is not impossible that if the key underlying reality happened to be math itself, mind and its intents could arise out of it through the unpredictable phenomenon of emergence. Reversely, if some Ur-mind (called the Original Mind in [9]) presided over the whole show, it is not inconceivable that OM would generate something like mathematics so as to structure itself and gain traction with itself and the real world.)

So which is it?

The first observation is that mathematics can *only* be fundamental in a finite Universe, because the Cantor antinomy [10] proves that if infinities are allowed into mathematics, it ultimately breaks down, and as such cannot be fundamental. Should mathematics be a fundamental, irreducible element of the reality of our universe or multiverse, then the universe cannot be infinite. It must remain finite, perhaps a hopelessly provincial realm in comparison with the boundless vistas that our mind's eye envisions when it dreams of infinity.

Reversely, because of something called the Bekenstein bound, which constrains the purviews and abilities of mind within finite dimensions, any form of mind can only qualify as fundamental in an *infinite* Universe.

Is there room for a "Third Party", something more fundamental than either mind or mathematics? In a finite universe, there can be no such Third Party, because math presides over, and governs, all interactions, all of the laws of physics which then trickle down and go on to govern materiality itself and all there is - physics, chemistry, biology, everything: math reigns supreme. In the case of an infinite multiverse, we can simply, in the absence of any more precise definition or specification of what a mind is, *interpret* the Ur-mind as being *by definition* the most fundamental and irreducible element there is within an infinite multiverse. In this latter case, any unrecognized fundamental 'Third Party' becomes coincident with and isomorphic to the Ur-mind.

Thus, we have come to a fork in the road: if our universe or multiverse is finite, then mathematics must be the ultimate truth. Everything reduces to relationships between elements, objects, things, wave functions and mind items. In such a universe, any existing mental aims and intentions must ultimately relate back to math, since math is all there is.

If the multiverse is infinite (an infinity then confirming the presence of the multiverse), then mind becomes more capable than mathematics. There is no reason why it should break down, whereas math ineluctably does.

3- Conclusion

The question of 'How mindless mathematical laws may give rise to intentions' may not have been fully legitimate as originally stated, and we examined both the term 'mindless' and the phrase 'give rise' to parse evidence of possible prior cognitive bias in the way the question was put. Doing away with any possible bias, we then sought to answer a new, more neutral version: 'How can mathematics enable mindful intentions?'

We ended up at a fork in the road, whereby possible answers unexpectedly hinge on whether the universe is finite or infinite. In the former case, mathematics remains consistent, and becomes the ultimate go-to fundamental whence everything else stems. In the latter case, mathematics can't keep up: it breaks down, and a not fully defined Ur-mind becomes the go-to fundamental: it is intentions that give rise to mathematics rather than the other way around.

There is, as of yet, no consensus on whether our universe or multiverse is finite or infinite. Many legitimate questions turn out to be unanswerable *in principle* (for instance, the simple question of a moving object's exact instantaneous position becomes fully unanswerable should we happen to know that object's exact speed.) Some people believe that the question of whether the universe or multiverse is infinite is one such unanswerable. Others beg to disagree and try to work out the answer. Until and unless they do, a definite answer to the question must remain elusive.

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[10] *see also* Edward Nelson, Warning Signs of a Possible Collapse of Contemporary Mathematics, *in* Michael Heller, W. Hugh Woodin, *editors* (2011). Infinity: New Research Frontiers. Cambridge University Press